A complicated bone fracture can be repaired by removing the damaged part of the bone and inserting in its place a correspondingly shaped replacement part. Such a replacement part usually grows together at the places of contact with the natural bone material within three to six weeks.

According to another embodiment of the present invention the composite material can be distributed in the form of a powder upon the surface of a suitably shaped article composed of a conventional bone replacing material, for instance, upon the surface of a bone shaped article of aluminum oxide or a metallic replacement part. The thus coated article is then subjected to a temperature treatment to cause sintering or fusing together of the powder coating and forming a porous sintered surface layer. Said layer retains the outstanding properties of the composite material and especially its biocompatibility and, as a result thereof, the thus refined aluminum oxide or metal bone replacement part can readily be implanted in the body.

The composite material of the present invention and articles made therefrom can also be provided with pigments or dyes dispersed therein for certain decorative purposes.

It is furthermore possible to optimize the parameters of solid-state body mechanics by purposeful incorporation in the manner of fiber-reinforced materials. Thus, for instance, the weight of the bone implant can be reduced by producing a compact tubular glass ceramic material and providing its cavity with the foamed composite material of the same composition. Care must be taken thereby, however, that the mechanical strength and stability properties of the resulting bone implant are not substantially reduced and impaired.

BRIEF DESCRIPTION OF THE DRAWING

The attached drawing illustrates diagrammatically in the form of a flow sheet the manner in which the process according to the present invention is carried out. As shown in the flow sheet the two starting materials A and B or mixtures thereof are subjected simultaneously or in rapid sequence to the individual process steps (a) and (b) and thereafter to process steps (c) and (d). Said process steps are carried out in known apparatus such as mills, presses, and furnaces under the above-described process conditions such as temperature, pressure, time, classifying of particle size, etc.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The following example serves to illustrate the present invention without, however, limiting the same thereto.

EXAMPLE

20 g. of fluorapatite ($Ca_5[F(PO_4)_3]$) prepared by precipitation from aqueous solution and representing the first starting material and 34 g. of a ground glass of the following composition, in weight percent:

46.2% of silicon dioxide SiO_2,
25.5% of tricalciumphosphate $Ca_3(PO_4)_2$,
20.2% of calcium oxide CaO,
2.9% of magnesium oxide MgO,
4.8% of sodium oxide Na_2O, and
0.4% of potassium oxide K_2O

are intimately mixed with each other and the mixture is processed according to the present invention as follows:

Step (a): The mixture of starting materials A and B is ground to a particle size not exceeding 500 μm. and is classified by means of a screen into two different fractions, one of them having a particle size not exceeding 350 μm.

Step (b): The mixture of such particle size is finely comminuted to a powder of the particle size of about 30 μm.

Step (c): The powder mixture is then compressed under a pressure of about 300 atmospheres so as to form the desired shaped body while heating at about 100° C. for a period of time of 20 minutes.

Step (d): The compressed and molded body is sintered at atmospheric pressure and at a temperature of about 670° C. for a period of 100 minutes.

The resulting molded and sintered body is used as bone replacement material.

Of course, the composition of the starting materials A and B can be varied as described hereinabove. Due to the many possibilities of selecting starting materials A and B of varying composition, the conditions under which the process according to the present invention is carried out can also be varied within the limits indicated.

Heat can be supplied in the sintering step (d) and/or during the compression step (c) or on presintering by all technologically feasible means and in particular by induction heating, by heating by means of an electron beam, or by heating by means of a laser beam.

Of course, many changes and variations in the composition of the starting materials A and B, in the particle size of said starting materials as produced by grinding and comminuting, in the classification, compressing and molding, presintering, and sintering conditions, in the use of the resulting composite material in medico-engineering, for osteosynthesis and for other purposes may be made by those skilled in the art in accordance with the principles set forth herein and in the claims annexed hereto.

We claim:

1. A process for the production of a composite therapeutically useful as a prosthetic material for replacing bones and teeth of humans and animals, said process comprising the steps of:

(a) comminuting a mixture of about 20 parts fluorapatite $Ca_5[F(PO_4)_3]$ prepared by precipitation and about 34 parts glass composition consisting essentially in weight percent of:
between about 20% and about 60% of silicon oxide, SiO_2,
between about 5% and about 40% of phosphorus pentoxide, P_2O_5,
between about 2.7% and about 20% of sodium oxide, Na_2O,
between about 0.4% and about 20% of potassium oxide, K_2O,
between about 2.9% and about 30% of magnesium oxide, MgO,
and between about 5% and 40% of calcium oxide, CaO,

(b) classifying the ground mixture by means of a screen into two fractions of different particle size;

(c) finely comminuting the fraction of smaller particle size to about 30 μm;

(d) compressing and molding the finely comminuted mixture into a shaped body at a pressure of about 300 atmospheres while simultaneously subjecting the mixture to a heat treatment of about 100° C for a period of about 20 minutes; and